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"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने की छोट नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 3438 (1994): Silvered glass mirrors for general purposes
[CHD 10: Glassware]
Indian Standard
SILVERED GLASS MIRRORS FOR GENERAL PURPOSES — SPECIFICATION
( Second Revision )

UDC 686.7

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

April 1994

Price Group 4
FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Glassware Sectional Committee had been approved by the Chemical Division Council.

This standard was first published in 1965 and revised in 1977. In this second revision requirements of silver and copper coating have been modified in view of the experience that a lower amount of silver coating does not impair the reflectance property of mirror and subsequently, a comparatively lower amount of copper deposition is suggested to avoid peeling off of the silver layer. To judge the optical quality of the mirror a better test by using ring and spot examination has been incorporated in this revision. The time cycle for the salt spray test has been enhanced and a new test “Hot water test” at 42°C has been included to ensure that the protective coating given at the back of the mirror is capable to sustain the unfavourable atmospheric conditions longer without any deterioration of the reflecting surface. Float glass has been permitted to be used in the manufacturing of mirrors.

In the preparation of this revised standard, due weightage has been given to International Standards and practices prevailing in other countries. This has been met by deriving assistance from the following publications:

- 12-GP-SA : 1970 — Mirrors, Silvered, Canadian Government Specifications Board
- DD-M-00411 b : 1968 — Mirrors, Glass Federal Supply Service, USA
- NBN S 23 — 001 : 1974 — Belgium Norms for Mirrors
- DIN 1238 : 1983 — German Regulations, Mirrors

The composition of the committee responsible for the formulation of the standard is given in Annex F.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
Indian Standard

SILVERED GLASS MIRRORS FOR GENERAL PURPOSES — SPECIFICATION

(Second Revision)

1 SCOPE
This standard prescribes requirements and methods of sampling and test for silvered glass mirrors used for general purposes.

2 REFERENCES
The following Indian Standards are necessary adjuncts to this standard:

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>264 : 1976</td>
<td>Nitric acid (second revision)</td>
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</tr>
<tr>
<td>2835 : 1987</td>
<td>Flat transparent sheet glass (third revision)</td>
</tr>
</tbody>
</table>

3 TERMINOLOGY
For the purpose of this standard, the definitions given in IS 1382 : 1981 shall apply.

4 REQUIREMENTS

4.0 General
Mirrors shall consist of glass sheet coated with silver on one surface. The silver shall be protected by a metallic copper film which in turn shall be covered by a suitable protective paint coating.

4.1 Glass Sheet
The glass sheet used for mirrors shall comply with the requirements prescribed for AA and A qualities of IS 2835 : 1987.

NOTE — Float glass may also be used if agreed to between the purchaser and the supplier.

4.2 Silvering
Silvering shall be a coating of deposited silver. It shall be free from defects or blemishes in the reflecting surface such as lifting or separation of the silver from the glass, sulphide or other spots, haze or any other visible defects. The amount of silver deposit shall not be less than 0.8 g/m² when determined in accordance with the method prescribed in Annex A.

4.3 Copper Coating
The silvered surface shall be protected by a film of deposited copper. The amount of copper deposit shall be not less than 0.4 g/m² when determined with the method prescribed in Annex A.

4.4 Protective Coating
A suitable protective paint coating shall be applied over the copper coating.

4.4.1 This paint coating shall not crack or peel the silver or copper coatings due to change in the atmospheric temperature or age-drying.

4.5 Reflectance
Reflectance of the mirrors shall not be less than 80 percent for clear (untinted) glass mirrors when tested in accordance with Annex B.

5 PERFORMANCE TEST

5.1 Test for Waviness
The test shall be carried out in a dark room so that secondary image and the white circle shall be distinctly visible.

5.1.1 Apparatus
The apparatus shall consist of a box 30 cm X 30 cm X 15 cm as shown in Fig. 1. The front of the box shall have a central hole of 12.7 mm diameter and a concentric slit of inside diameter 79.2 mm and width 1.6 mm for mirrors made of float glass and a central hole of 12.7 mm diameter and a concentric slit of inside diameter 48.1 mm and width 1.6 mm for mirrors made of sheet glass forming a 'ring and spot' target. The front panel may be of glass masked with opaque black paper or of metal sheet painted matt black; in the latter case, the spinders bridging the slit should be small and disposed at 45° to the vertical and horizontal axes. The box shall be illuminated by a 15 or 25 watt pearl bulb and the central hole shall be covered by a yellow-red filter, for example, 'Ilford red 608'. The inside of the box shall be painted white.

5.1.2 Procedure
Place the light box so that the centre of the target lies on a horizontal line passing through
For Sheet Glass Mirrors
Distortion Limit — 15 minutes
(Angle $\theta$)
Distance $\tan \theta = \frac{79.2 - 12.7}{7600} = \frac{L}{R}$
$\theta = 15$ minutes.

For Float Glass Mirrors
Distortion Limit — 1 minute
(Angle $\theta$)
Distance $\tan \theta = \frac{48.10 - 12.7}{7600} = \frac{L}{R}$
$\theta = 8$ minutes.

NOTE — The mirror will be kept at a distance of 3 800 mm from light-box.

All dimensions in millimetres

FIG. 1 APPARATUS FOR WAVINESS TEST

the centre of the mirror placed at a distance of
3'8 m from the light box. View the light
box through each part of mirror standing very
near the mirror in order to detect the presence
of any secondary image associated with the
illuminated target. A monocular ($\times 5$) will
assist in viewing and decrease eye strain.

5.1.3 Interpretation of the Result

a) For mirrors made of sheet glass:

1) Using the ‘ring and spot’ target, there
shall be no displacement of the
secondary image beyond the point of

2) There shall not be more than two
secondary images.

3) When the full manufacturing size is
subjected to this test, a band of
100 mm width parallel to the direction
of draw (waviness) at both ends shall
be deleted from this test.
b) For mirror made of float glass:
   1) The maximum deviation will be 8 minutes of arc.
   2) There shall be not more than one secondary image.

5.2 Salt Spray Test
It shall pass the test as prescribed in Annex C.

5.3 Hot Water Test
It shall pass the test as prescribed in Annex D.

5.4 Testing of Copper and Silver Plating
Remove the protective coating (see 4.4) by suitable removers and promptly flush the surface with water. No silver shall be visible through the exposed metallic copper plating.

5.4.1 On further treatment of copper plating with concentrated ammonia, a clear silver film without any pinholes, blemishes or other visual defects shall be exposed.

6 PACKING AND MARKING

6.1 Packing
Mirrors shall be packed as agreed between the purchaser and the supplier.

6.2 Marking
Each mirror shall bear a label, affixed by the manufacturer, giving the following information:
   a) Quality of glass used as 'F' for float, 'AA' or 'A' for sheet quality;
   b) Indication of the source of manufacture; and
   c) Lot number or batch number for traceability.

7 SAMPLING

7.1 Representative samples of mirrors shall be drawn and conformity of the material to the requirements of this specification shall be determined in accordance with the procedures prescribed in Annex E.

ANNEX A
( Clauses 4.2 and 4.3 )

TEST FOR SILVER AND COPPER COATINGS

A-0 PRINCIPLE

A-0.1 The silver and copper deposits are dissolved in nitric acid. Silver is estimated by titrating with ammonium thiocyanate solution. Copper is estimated by comparing the intensity of cuproammonium complex of the test solution with that of a standard copper solution.

A-1 QUALITY OF REAGENTS

A-1.1 Unless specified otherwise, pure chemicals and distilled water (see IS 1070:1992) shall be employed in tests.

NOTE — ‘Pure chemicals’ shall mean chemicals that do not contain impurities which affect the results of analysis.

A-2 APPARATUS

A-2.1 Nessler Cylinders
Two, of 100 ml capacity.

A-3 REAGENTS

A-3.1 Concentrated Nitric Acid — See IS 264:1976.

A-3.2 Standard Ammonium Thiocyanate Solution
0.01 N silver nitrate solution using ferric ammonium sulphate solution as indicator.

A-3.3 Ferric Ammonium Sulphate Solution
Dissolve 8 g of ferric ammonium sulphate in 400 ml of water containing 3 to 5 ml of concentrated sulphuric acid (see IS 266:1993). Cool, transfer to a 1 000 ml volumetric flask and dilute with water up to the mark. Further dilute 100 ml of this solution to 1 000 ml in a volumetric flask. One millilitre of this diluted solution is equivalent to 0.1 mg of copper (as Cu).

NOTE: AR Grade copper sulphate of purity 99.5 percent Min is to be used.

A-3.4 Standard Copper Solution
3.93 g of copper sulphate (CuSO₄.5H₂O) in 200 ml of water and add with stirring 50 ml of concentrated sulphuric acid (see IS 266:1993). Cool, transfer to a 1 000 ml volumetric flask and dilute with water up to the mark. Further dilute 100 ml of this solution to 1 000 ml in a volumetric flask. One millilitre of this diluted solution is equivalent to 0.1 mg of copper (as Cu).

NOTE: AR Grade copper sulphate of purity 99.5 percent Min is to be used.

A-3.5 Ammonium Hydroxide Solution
Approximately 10 N.

A-4 PROCEDURE

A-4.1 Take a sample of known area for analysis. Remove any paint or varnish from the mirror back with benzene or denatured spirit. Dissolve
the copper/silver deposits using minimum quantity of nitric acid distributing the acid over the mirror back with a glass rod. Wash the nitric acid containing copper/silver into a 200 ml porcelain basin and evaporate the solution to dryness carefully on a sand-bath. Dissolve the residue in 3 to 5 drops of nitric acid and a little water. Boil the solution, cool and transfer to a 250 ml volumetric flask and make up the volume to the mark with water.

A-4.2 Determination of Silver

Take a 50 ml aliquot of the solution prepared in A-4, and titrate with standard ammonium thiocyanate solution, using 5 ml of ferric ammonium sulphate solution, until the brown colour appears.

A-4.2.1 Calculation

Silver deposit (expressed as g/m²) = \( \frac{V \times N \times 5 \times 10^8}{A} \times \frac{1}{10} \)

where

- \( V \) = volume in ml of standard thiocyanate solution added;
- \( N \) = normality of the standard ammonium thiocyanate solution; and
- \( A \) = area of the mirror specimen in square decimetre.

A-4.3 Determination of Copper

Take a 10 ml aliquot of the solution prepared in A-4, and transfer it to a 100 ml Nessler cylinder. Add 10 ml of ammonium hydroxide solution and make to 100 ml mark with water. Transfer to a second 100 ml Nessler cylinder 10 ml of ammonium hydroxide solution and 5 ml of water. Add standard copper solution (A-3.4) to this Nessler cylinder drop by drop until on dilution to the mark with water, the blue colour of the solutions in both Nessler cylinders matches.

A-4.3.1 Calculation

Copper deposit (expressed as g/m²) = \( \frac{25V}{A} \times \frac{1}{10} \)

where

- \( V \) = volume in ml of standard copper solution used, and
- \( A \) = area of the mirror specimen in square decimetre.

NOTES

1 A sample mirror 150 mm × 150 mm is usually taken for analysis.
2 It is essential that the evaporation takes place in the absence of hydrochloric acid fumes.
3 Even though the solution of copper/silver deposits may be slightly cloudy the solution is transferred to the flask without filtering.

ANNEX B

( Clause 4.5 )

REFLECTANCE TEST FOR MIRRORS

B-1 APPARATUS

B-1.1 Light Source

A 500 watt projector with a standard lamp which can project almost parallel incident light and of 19 mm Min in diameter.

B-1.2 Light Receptor and Indicator

The accuracy including the receptor shall be not more than ±2 percent of the maximum scale value or not more than ±10 percent of the magnitude of reading, whichever is less. However, the reflectance may be obtained by calculation after measurement with the illuminance meter.

B-2 PROCEDURE

The receptor is arranged on the optical axis of the projector of a light source as given in Fig. 2. When there is no incident light on the receptor, the scale of an indicator is aligned with the zero by a zero adjustment dial. Further when the light of the projector is directly received, the scale of the indicator is aligned with 100 percent by an indication adjustment dial.

Then, the mirror to be measured is placed before the projector as shown in Fig. 2. The reflected light is received by moving a receptor and the scale of the indicator at that time is read out.

B-3 RESULT

The reflectance of the mirror shall be measured as the percentage of the indicator reading without mirror.
ANNEX C

(Clause 5.2)

SALT SPRAY TEST

C-1 GENERAL

The test is used as an accelerated test to assess the resistance of the paint coating on silvered glass to adverse environmental conditions over an extended period of time.

C-2 REAGENTS

C-2.1 Salt Solution

20 percent (w/v) sodium chloride in demineralised water. Sodium chloride should not contain more than 0.1 percent of iodide and not more than 0.3 percent of total impurities. LR quality salt shall be used.

C-2.1.1 pH of Salt Solution

The pH of the atomised salt solution should be controlled between 6.5 to 7.2 throughout the test.

C-3 SAMPLING

Cut test specimens from the corners of the glass mirrors in 150 mm X 200 mm size.

C-4 PROCEDURE

Place the prepared specimens of mirrors in the salt spray cabinet, with the reflectance surface up at an angle of 45° with the horizontal. The specimens are separated from one another by at least 5 mm. Subject the specimen to the spray of salt water at 36 ± 2°C for 120 hours. The specimens are withdrawn from the cabinet for 1 hour after every 24 hours cycle. At each withdrawal the specimens are rinsed with distilled water and examined for defects of silver surface such as spots, fog, cloudiness, haze, discoloration, blackening. After examining, the specimens are put in the original position in the Salt Spray Cabinet and subjected to salt spray. The total period of removal of the samples from the cabinet should not be included in the 120 hours cycle. At the end of the test, mirror specimens shall be removed, rinsed with clear water and dried.

C-5 INSPECTION OF THE DEFECTS

The viewing distance shall be approximately 46 cm with normal vision. Illumination shall be with two 40-watts fluorescent tubes at a distance of 120 cm to 150 cm.

C-6 LIMITS OF DEFECTS

a) Any clouding, haze, fog, discoloration, blackening, separation of silver film is not permitted.

b) Any spotting or silver impairment greater than a total of 7 spots on the reflectance
surface (5 with diameter less than 0.5 mm and 2 with diameter less than 3.00 mm) are not allowed.

c) Any defect which develops in the silvered area within 16 mm from the edges shall be disregarded.

NOTE — When pH of the salt solution is adjusted at room temperature and atomised at 36°C, the pH of the collected solution will be higher than the original solution due to the loss of carbon dioxide at higher temperature. When the pH of the salt solution is adjusted at room temperature, it is therefore, necessary to adjust it below 6.6 so the collected solution after atomising at 36°C will meet the pH limits of 6.8 ±0.2. The adjustment of pH can be done by the addition of dilute HCl or dilute NaOH solution.

ANNEX D
(Clauses 5.3)

HOT WATER TEST

D-1 PROCEDURE
Cut test specimens from the corners of the glass mirrors, as large as possible, but not exceeding 150 mm x 200 mm in size.
Immure the prepared specimens of mirror in a glass jar containing demineralised water kept at 42 ±2°C. Keep the specimens for 8 hours in the hot water jar and then leave standing under normal room conditions for 16 hours to complete one cycle. The cycle shall be repeated 10 times. At the end of each cycle the specimens are examined for any visible defects of the reflecting surface and any peeling off of the paint backing.

D-2 INTERPRETATION OF THE RESULT
After completion of 10 cycles there shall not be any visible defects on the reflecting surface and any peeling off of the paint backing within 16 mm from the edges of the sample.

ANNEX E
(Clauses 7.1)

SAMPLING OF SILVERED GLASS MIRRORS FOR GENERAL PURPOSES

E-1 SCALE OF SAMPLING

E-1.1 Lot
In a single consignment, all silvered glass mirrors of the same quality of glass used and belonging to the same batch of manufacture shall be grouped together to constitute a lot.

E-1.2 The conformity of the lot to the requirements of this specification shall be ascertained for each lot separately. The number of glass mirrors to be selected for this purpose shall depend on the size of the lot and shall be in accordance with col 1, 2 and 3 of Table 1.

E-1.3 The glass mirrors selected according to col 2 and 3 of Table 1 shall be examined for visual characteristics given in 4.1, 4.2, 4.3, 4.4 and 5.1 in two stages. A glass mirror failing to satisfy any of these requirements shall be considered as defective. The lot shall be considered as conforming to the requirements if the number of defective glass mirrors found in the sample at the first stage is less than or equal to the corresponding acceptance number given in col 5 of Table 1. The lot shall be rejected without any further testing if the number of defective glass mirrors in the sample is greater than or equal to the corresponding number given in col 6 of Table 1.

E-1.3.1 If the number of defective glass mirrors found in the sample lies between \( a \) and \( r \), a second sample of the size given in col 3 of Table 1 shall be selected. The lot shall be considered as conforming to these requirements if the number of defective found in the cumulative sample (first and second sample combined) is less than or equal to the corresponding acceptance number given in col 5 of Table 1; otherwise the lot shall be rejected.

E-1.4 The lot which has passed visual requirements shall be further examined for characteristics requiring destructive testing. For this purpose, a sub-sample of the size given in col 7 of Table 1 shall be taken from those examined under 5.1 and found satisfactory. Each of the glass mirrors in the sub-sample shall be tested for characteristics given in 5.2, 5.3, 5.4 and 5.4.1. The test specimens of required dimensions shall be cut from each glass mirror in the sub-sample and subjected to the tests given in 5.2, 5.3, 5.4 and 5.4.1. The lot shall be considered
as meeting the requirements under this clause E-1.5 The lot shall be considered as conforming if none of the glass mirrors in the sub-sample to the requirements of this specification if E-1.3 and E-1.4 are satisfied.

Table 1 Scale of Sampling and Permissible Number of Defectives
( Clauses E-1.2, E-1.3, E-1.3.1, and E-1.4 )

<table>
<thead>
<tr>
<th>SI No.</th>
<th>No. of Mirrors in the Lot</th>
<th>Visual Requirements</th>
<th>Number of Defectives</th>
<th>Sub-sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Up to 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>101 to 300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>301 to 500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>501 to 1000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1001 and above</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ANNEX F
( Foreword )

COMMITTEE COMPOSITION

Glassware Sectional Committee, CHD 010

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SHRI L. V. RAJ
SHRI PARTHO DATTA ( Alternate )

Representing
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Ministry of Defence, DGQA ( GS ), Kanpur

Export Inspection Council of India, New Delhi

Central Glass and Ceramic Research Institute, Calcutta

The Indo-Asahi Glass Co Ltd, Calcutta

Ballarpur Industries Ltd, New Delhi

Hindustan National Glass and Industries Ltd, Calcutta

Indian Institute of Packaging, Bombay

Peico Electronic and Electricals Limited, Bombay

Mohan Crystal Glass Works, Ghaziabad

United Breweries Ltd, Bangalore

Hind Lamps Ltd, Shikohabad

Eagle Flasks Industries ( India ) Pvt Ltd, Bombay

Alembic Glass Industries Ltd, Vadodara

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Borosil Glass Works Ltd, Bombay

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( Continued on page 8 )
(Continued from page 7)

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SMT MEENAL PASSI
Assistant Director (Chem), BIS
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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such a review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of ‘BIS Handbook’ and ‘Standards Monthly Addition’.

This Indian Standard has been developed from Doc: No. CHD 010 (9173)

Amendments Issued Since Publication

<table>
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<tr>
<th>Amend No.</th>
<th>Date of Issue</th>
<th>Text Affected</th>
</tr>
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Printed at Paragon Enterprises, Delhi, India
AMENDMENT NO. 1 MAY 2002
TO
IS 3438 : 1994 SILVERED GLASS MIRRORS FOR
GENERAL PURPOSES — SPECIFICATION
(Second Revision)

(Page 2, Fig. 1B, Description 'For Float Glass Mirrors, line 1') —
Substitute the following for the existing:

'Distortion Limit — 8 minutes'
(Angle \( \theta \))

(CHD 10)

Reprography Unit, BIS, New Delhi, India
AMENDMENT NO. 2 JANUARY 2006
TO
IS 3438 : 1994 SILVERED GLASS MIRRORS FOR GENERAL PURPOSES — SPECIFICATION
(Second Revision)

(Page 1, clause 2) — Substitute the following for the existing clause:

2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

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<td>2835 : 1987</td>
<td>Specification for flat transparent sheet glass (third revision)</td>
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</table>

(Page 1, clause 5.1.1, sixth line) — Substitute ‘sheet glass’ for ‘float glass’.

(Page 1, clause 5.1.1, ninth line) — Substitute ‘float glass’ for ‘sheet glass’.

(Page 3, clause 6.2) — Insert the following at the end:

6.3 BIS Certification Mark

Each mirror may also be marked with the Standard Mark.

6.3.1 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

(CHD 10)